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Alfalfa Weevil Distribution and Crop Damage in the United States[1]

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INTRODUCTION

The alfalfa weevil (*Hypera postica* (Gyll.)) has received Nation-wide attention since its introduction in 1904, and has been the object of many State quarantines. Its distribution and its damage to the alfalfa crop are important to both infested and uninfested States. This circular presents (1) available information up to 1940 on all counties in which the weevil has been found, (2) a summary of scouting in other areas which yielded negative results, (3) a history of injury during the earlier years of the weevil's occurrence in this country, and (4) an appraisal of the damage this insect inflicted during 1936-38 in the more important agricultural sections of the infested area. The data presented will be of interest to those engaged in research affecting alfalfa hay and seed production, to State regulatory officials, and to agricultural extension workers.

[1] Submitted for publication March 29, 1949.

[2] Died June 8, 1943.

DISTRIBUTION OF THE ALFALFA WEEVIL

Scouting to determine the distribution and abundance of the alfalfa weevil is most effectively conducted when the insect is in the larval stage and hence multiplied in number some 200 to 400 times over the parent weevil population. That being the time when other work was most pressing, scouting reported in this publication received attention only as other research activities permitted.

At the end of 1940, 37 years after the alfalfa weevil first attracted attention at Salt Lake City, Utah, it had been found in 141 counties distributed among 11 western States. The counties found infested, together with the year of the original discovery and the date the weevil was last detected by representatives of the Bureau of Entomology and Plant Quarantine, or by cooperating State officials, are listed in table 1.

TABLE 1.—*Counties found infested by the alfalfa weevil, 1904-40*

State and county	Infestation		State and county	Infestation	
	Discovered	Last detected[1]		Discovered	Last detected[1]
	Year	*Year*		*Year*	*Year*
ARIZONA			IDAHO		
Coconino	1935	1935	Ada	1919	1938
			Adams	1928	....
CALIFORNIA			Bannock	1916	1938
Alameda	1932	1938	Bear Lake	1911	1916
Alpine	1929	....	Bingham	1916	1939
Contra Costa	1932	1935	Blaine	1921	....
Lassen	1924	....	Boise	1928	....
Merced	1933	1938	Bonneville	1919	1938
Modoc	1937	....	Butte	1921	....
Mono	1932	....	Camas	1921	....
Plumas	1924	1925	Canyon	1919	1938
San Joaquin	1932	1938	Caribou	1920	....
Santa Clara	1932	1938	Cassia	1915	1938
Sierra	1923	....	Clark	1920	1920
Siskiyou	1934	1935	Custer	1921	....
Stanislaus	1932	1938	Elmore	1923	1938
			Franklin	1917	1936
COLORADO			Fremont	1917	1938
Delta	1917	1938	Gem	1920	1938
Eagle	1936	1936	Gooding	1921	1939
Garfield	1928	1935	Jefferson	1920	1938
Gunnison	1918	....	Jerome	1920	1939
Larimer	1939	1939	Lincoln	1920	....
Mesa	1928	1939	Madison	1917	1938
Moffat	1926	1932	Minidoka	1920	1936
Montezuma	1935	1938	Oneida	1914	1916
Montrose	1919	1938	Owyhee	1921	1938
Ouray	1926	1937	Payette	1918	1938
Pitkin	1938	....	Power	1918	....
Rio Blanco	1926	1926	Teton	1930	1936
Routt	1926	1926	Twin Falls	1920	1938
Weld	1938	1938	Washington	1919	1938

TABLE 1.—*Counties found infested by the alfalfa weevil, 1904-40 (Continued)*

State and county	Infestation	
	Discovered	Last detected[1]
	Year	*Year*
MONTANA		
Big Horn	1938	1939
NEBRASKA		
Banner	1938	1938
Box Butte	1936	1938
Dawes	1936	1937
Kimball	1938	1938
Morrill	1939	1939
Scotts Bluff	1935	1939
Sheridan	1939	1939
Sioux	1928	1938
NEVADA		
Churchill	1924	1938
Clark[2]	1935	1935
Douglas	1927	1938
Elko	1928	1939
Humboldt	1928	1930
Lander	1930	1930
Lincoln	1928	1935
Lyon	1924	1938
Mineral	1926	....
Ormsby	1926	....
Pershing	1922	1928
Storey	1922	....
Washoe	1920	1938
White Pine	1920	1928
OREGON		
Baker	1922	1938
Douglas	1938	1938
Harney	1936	1936
Jackson	1929	1939
Josephine	1933	1938
Malheur	1919	1938
Union	1924	1937
SOUTH DAKOTA		
Custer	1937	1937
Fall River	1936	1937
UTAH		
Beaver	1920	1920
Box Elder	1911	1938
Cache	1912	1938
Carbon	1917	1920
Daggett[3]	1936	1936
UTAH (con.)		
Davis	1909	1936
Duchesne	1916	1938
Emery	1920	1934
Garfield	1923	1928
Grand	1929	1935
Iron	1922	1933
Juab	1912	1920
Kane[3]	1935	1935
Millard	1912	1940
Morgan	1910	1936
Piute	1921	1923
Rich	1911	1915
Salt Lake	1904	1940
San Juan	1932	....
Sanpete	1912	1940
Sevier	1916	1940
Summit	1906	1929
Tooele	1910	1933
Uintah	1923	1938
Utah	1910	1940
Wasatch	1910	1938
Washington	1924	1926
Wayne[3]	1935	1936
Weber	1910	1936
WYOMING		
Big Horn	1938	1938
Campbell	1937	1937
Carbon	1926	1940
Converse	1925	1936
Crook	1939	1939
Fremont	1925	1938
Goshen	1926	1937
Hot Springs	1938	1938
Johnson	1937	1937
Laramie	1938	1938
Lincoln	1915	1915
Natrona	1925	1926
Niobrara	1927	1936
Park[4]	1938	....
Platte	1925	1927
Sheridan	1937	1937
Sweetwater	1914	1920
Uinta	1911	1936
Washakie	1938	1938
Weston	1937	1937

[1]By representatives of the Bureau of Entomology and Plant Quarantine.

[2]See text, page 15.

[3]Probably infested years earlier but not actually determined until date shown.

[4]Discovered by representatives of the Wyoming State Entomologist's office.

Additional scouting in the years 1935-40, inclusive, involved more than 827,225 sweeps of an insect net, and showed no infestation in 147 counties located in 13 States (table 2).

TABLE 2.—*Counties scouted for the alfalfa weevil with negative results, 1935-40*

State and county[1]	Times surveyed	Fields swept	Total sweeps
	Number	*Number*	*Number*
ARIZONA			
Mohave	2	..	.....
CALIFORNIA			
Amador	1	2	1,500
Butte	2	17	13,500
Calaveras	1	[2] 0	.....
Colusa	3	25	17,500
Eldorado	1	[2] 0	.....
Fresno	2	31	16,500
Glenn	2	16	13,000
Humboldt	1	2	1,000
Inyo (1928)	..	..	.....
Kern	1	25	23,500
Kings	2	12	5,550
Lake	2	12	5,400
Los Angeles	1	44	38,450
Madera	2	22	11,150
Mariposa	1	[2] 0	.....
Mendocino	1	8	8,000
Merced	1	35	13,500
Monterey	..	..	.....
Nevada	2	1	500
Orange	1	10	7,500
Placer	2	3	2,100
Riverside	1	32	21,400
Sacramento	3	34	22,000
San Benito	1	3	1,000
San Bernardino	1	31	19,850
Shasta	2	21	15,200
Solano	3	27	19,200
Sutter	3	24	16,500
Tehama	2	19	14,500
Trinity	1	2	1,000
Tulare	1	20	12,300
Tuolumne	1	[2] 0	.....
Yolo	3	34	24,000
Yuba	3	20	13,000
COLORADO			
Adams	3	15	11,600
Alamosa (1928)	..	..	.....
Arapahoe	1	6	5,500
Boulder	1	20	19,500
Chaffee	1	10	5,000
Crowley	1	3	1,500
Denver (1928)	..	..	.....

TABLE 2.—*Counties scouted for the alfalfa weevil with negative results, 1935-40 (Continued)*

State and county[1]	Times surveyed	Fields swept	Total sweeps
	Number	*Number*	*Number*
COLORADO (con.)			
Dolores	1	[2] 0	.....
Douglas	1	2	1,000
Elbert	1	1	500
El Paso	1	1	500
Huerfano	1	3	1,500
Jefferson	1	8	6,000
La Plata	2	26	17,750
Las Animas	1	1	500
Logan	3	18	14,350
Morgan	3	27	21,600
Otero	1	2	1,000
Pueblo	1	5	2,500
Sedgwick	2	11	9,300
San Miguel	2	7	6,200
Washington	2	2	1,500
IDAHO			
Nez Perce (1925 and 1934)	..	..	.....
Valley (1921)	..	..	.....
IOWA			
Harrison[3]	1	4	4,150
Mills[3]	1	1	500
Pottawattamie[3]	2	13	8,850
KANSAS			
Dickinson	1	3	3,400
Douglas	1	1	1,700
Ellis	1	7	8,900
Ellsworth	1	3	2,900
Geary	1	1	1,050
Jefferson	1	2	2,300
Leavenworth	1	2	2,500
Marshall	1	4	5,500
Pottawatomie	1	7	6,250
Riley	1	3	3,550
Saline	1	7	7,050
Shawnee	1	5	5,400
Wyandotte	1	3	4,250
MONTANA			
Beaverhead (1914, 1920, 1925, and 1927)	..	..	.....
Carbon	2	6	3,500
Carter	2	2	1,000
Custer	1	3	1,400
Gallatin (1920)	..	..	.....
Jefferson (1925)	..	..	.....
Madison (1925 and 1927)	..	..	.....
Park	1	..	.....
Powder River	2	10	5,050
Richland	1	6	2,900
Rosebud	1	6	3,400
Stillwater	1	3	1,450
Yellowstone	2	12	7,000

TABLE 2.—*Counties scouted for the alfalfa weevil with negative results, 1935-40 (Continued)*

State and county[1]	Times surveyed	Fields swept	Total sweeps
	Number	*Number*	*Number*
NEBRASKA			
Antelope[4]	1	5	2,500
Boone[4]	1	5	2,500
Brown[4]	1	1	500
Buffalo[3]	2	9	7,300
Butler[3]	1	2	1,150
Cass[4]	1	5	2,500
Cheyenne	2	3	1,400
Colfax[3]	2	4	2,300
Cuming[4]	1	5	2,500
Dawson[3]	2	10	8,600
Deuel[3]	1	2	1,000
Dodge[3]	2	4	3,400
Douglas[3]	2	5	4,400
Fillmore[4]	1	5	2,500
Gage[4]	1	5	2,500
Garden	1	3	3,050
Garfield[4]	1	5	2,500
Greeley[4]	1	5	2,500
Hall[3]	2	3	1,900
Hamilton[3]	1	3	1,450
Jefferson[4]	1	5	2,500
Johnson[4]	1	5	2,500
Keith[3]	1	5	4,550
Lancaster[3]	1	5	6,000
Lincoln[3]	2	12	8,650
Merrick[3]	2	7	5,750
Nemaha[4]	1	5	2,500
Otoe[4]	1	5	2,500
Pawnee[4]	1	5	2,500
Platte[3]	1	2	1,450
Polk[4]	1	5	2,500
Richardson[4]	1	5	2,500
Rock[4]	1	1	500
Saline[4]	1	5	2,500
Sarpy[4]	2	8	4,600
Saunders[4,3]	3	11	6,300
Thayer[4]	1	5	2,500
Valley[3]	1	7	5,300
Washington[4]	1	2	1,000
Wayne[4]	1	5	2,500
Wheeler[4]	1	2	1,000
York[4]	1	5	2,500
NEVADA			
Eureka (annually 1926-30)	..	..	.....
NEW MEXICO			
Colfax	1	1	500
Rio Arriba	1	3	1,500
San Juan	1	6	3,000
Santa Fe	1	1	500
Taos	1	2	1,000

TABLE 2.—*Counties scouted for the alfalfa weevil with negative results, 1935-40 (Continued)*

State and county[1]	Times surveyed	Fields swept	Total sweeps
	Number	*Number*	*Number*
NORTH DAKOTA			
Billings	1	3	2,700
McKenzie	1	3	1,500
OREGON			
Clackamas (1931)	..	..	.....
Crook (1924 and 1931)	..	..	.....
Deschutes	1	..	1,900
Franklin (1930)	..	..	.....
Gilliam (1926)	..	..	.....
Grant	2	..	7,300
Hood River (1931)	..	..	.....
Jefferson (1929 and 1930)	..	..	.....
Klamath	1	11	5,500
Lane	1	11	5,500
Morrow	1	..	3,500
Sherman (1929)	..	..	.....
Umatilla	2	..	5,750
Wallowa	1	10	9,000
Wasco (1921, 1930, and 1931)	..	..	.....
Wheeler (1921, 1924, 1925, and 1931)	..	..	.....
SOUTH DAKOTA			
Butte	3	8	4,350
Harding	1	1	300
Lawrence	3	16	8,850
Meade	3	10	4,675
Pennington	3	11	5,850
Shannon	1	2	850
WASHINGTON			
Asotin (1924, 1925, 1929, and 1934)	..	..	.....
Benton	1	10	5,150
Columbia (1930)	..	..	.....
Garfield (1925, 1930, and 1931)	..	..	.....
Walla Walla	1	7	5,300
Whitman (1930)	..	..	.....
Yakima	1	17	9,000
WYOMING			
Albany	4	11	6,350
Sublette	1	7	8,500
Teton	1	10	10,000

[1]The names of additional counties scouted before 1935, which were not found infested and which have not been surveyed since, are followed by the years (in parentheses) in which they were scouted.

[2]No alfalfa fields found.

[3]Included in special scouting in the vicinity of the Union Pacific rights-of-way from Nebraska to Council Bluffs, Iowa, 1939 or 1940.

[4]Received alfalfa hay in the winter of 1934-35 from weevil-infested areas in the Great Basin during a temporary relaxation of the alfalfa weevil quarantine in Nebraska

HISTORY OF ALFALFA WEEVIL DAMAGE AND ITS APPRAISAL, 1936-38, BY STATES

The status of the alfalfa weevil as a crop pest in the United States is shown by a history of weevil damage and an appraisal of weevil injury made in 1936-38. The history of damage has been assembled from information gathered by State officials and from Bureau records. The appraisal surveys were made entirely by the Bureau. Before the discussion of findings in the various weevil-infested States is presented, however, the scope and methods of these surveys will be outlined.

Appraisal surveys were begun in 1936 to determine the actual economic importance of the alfalfa weevil some three decades after its discovery in the United States. In conjunction with the estimates of weevil damage, sufficient ecological work of a simplified nature was performed to determine the essential trends of the weevil and its parasite *Bathyplectes curculionis* (Thoms.). In most of the older infested areas and in some more recently infested, where the parasite has spread naturally or has been established through domestic redistribution performed by the Bureau of Entomology and Plant Quarantine, these trends were found to be closely comparable to those determined for Salt Lake Valley, Utah, in the course of several years of detailed ecological work.[3]

The findings of special importance resulting from these ecological studies are as follows: (1) In most areas having a history of weevil damage, the spring growth of alfalfa usually reaches the flower-bud stage before the injury becomes serious; (2) the alfalfa can be cut in that stage, with improvement of the hay quality; (3) second-crop shoots are not then present and the second crop will not be retarded if the first crop is cut at the bud stage; and (4) the kill of early weevil larvae by the imported parasite, supplemented by the cultural kill of younger larvae due to starvation and heat after early harvest, result in holding to very small numbers the new-generation adult weevils which partly serve to carry the species over winter.

If, however, harvesting is delayed beyond the flower-bud stage, more and more weevil larvae which have escaped the parasite spin their cocoons, pupate, and emerge as adults before removal of the first crop. Those adults then seek shelter beneath alfalfa crowns and in soil cracks, where they may survive the stubble-field heat. In fields having injurious numbers of weevil larvae, delayed harvest also results in very rapid increase in injury to the first crop of alfalfa; and if the first harvest is delayed until the second crop has started, the larvae will retard the growth of the latter after the former is cut.

The second crop should also be cut at the flower-bud stage, not to avert weevil damage to the maturing second crop, but to reduce the second contingent of the new generation of weevils. These new-generation weevils would otherwise mature on the crop and add to the number of adults wintering over to produce another generation on the new growth the following spring.

All appraisal surveys were made by entomologists thoroughly trained

[3] HAMLIN, J. C., LIEBERMAN, F. V., BUNN, R. W., MCDUFFIE, W. C., NEWTON, R. C., and JONES, L. J. FIELD STUDIES OF THE ALFALFA WEEVIL AND ITS ENVIRONMENT. U. S. Dept. Agr. Tech. Bul. 975, 84 pp., 1949.

in the methods employed in making the detailed ecological studies, and in accordance with plans drawn to provide information on the essential factors governing weevil abundance and damage—namely, the number and sizes of weevil larvae present, and the percentage of parasitization, in relation to growth and maturity of the first alfalfa crop, its harvest, and the weather. Owing to the brief period available annually for appraisal studies, the surveys were necessarily limited mainly to the more important alfalfa-producing districts having a history of weevil damage, and were so distributed over the infested territory as to enable generalization concerning the damage and the conditions permitting it.

The gray appearance of damaged alfalfa fields, which results from skeletonizing of the leaves by weevil larvae and the subsequent drying of the leaf veins, was designated as a tangible, easy way to recognize injury involving economic loss. The estimate of damage was based upon the percentage of fields thus grayed, and the loss was classed as slight, moderate, or severe, in accordance with the proportion of foliage affected in the spread of the injury downward on the plants. Another type of damage, much more injurious than it appears to be, results when many newly hatched larvae concentrate upon the growing tips, giving them a ragged appearance and effectively stopping growth. This injury develops later into the more conspicuous gray type previously described. Unless otherwise specified, all damage relates to the spring growth of alfalfa.

Retardation of the second growth of alfalfa immediately after the harvesting of the first crop was reported as prevalent and was regarded as the most destructive feature of alfalfa weevil damage during the early years of this insect's occurrence in the United States. However, the decline of this type of injury was reported[4] as early as 1924, and since then the status of the alfalfa weevil as a pest has depended mostly upon its damage to the first crop. Information on the present-day retardation of the second growth was particularly sought in the appraisal surveys, and has been reported for each district where it occurred or was in prospect.

Arizona

There is no history of economic damage by the alfalfa weevil in Coconino County.

California

Information supplied by Stewart Lockwood of the California Department of Agriculture and A. E. Michelbacher[5] and E. O. Essig of the University of California shows that injury by the alfalfa weevil in California has been extremely localized and of negligible economic importance to the agriculture of the State. In the very small infested area east of the Sierra Nevada Mountains serious injury occurs in a small percentage of fields. For instance, during the period 1926-35 the estimated annual loss of the first crop in Lassen County ranged from 0 to 6 percent and averaged 2.5 percent. Economic loss in the infested counties of middle lowland California has been entirely negligible, with only a very

[4] Chamberlin, T. R. introduction of parasites of the alfalfa weevil into the united states. U. S. Dept. Agr. Cir. 301, 9 pp., illus. 1924.

[5] Michelbacher, A. E. the present status of the alfalfa weevil in california. Calif. Agr. Expt. Sta. Bul. 677, 24 pp., illus. 1943.

few fields experiencing slight to moderate feeding on the first growth. Weevil injury in Siskiyou, Modoc, and other infested counties at higher elevations has been negligible to slight. On account of the lack of injury by the weevil in California, no appraisal studies were made in that State by Bureau representatives.

Colorado

HISTORY

Weevil damage in Colorado has been restricted to the western slope of the Rocky Mountains. The summary that follows is based upon reports received from J. H. Newton of the Colorado State Entomologist's office. Economic damage occurred in the following counties: Delta in 1917-21; Montrose in 1921; Delta, Montrose, and Moffat in 1926 and again in 1931-32; Rio Blanco in 1929-31; and Mesa in 1932-36. In all these counties, since the initial occurrence of severe damage, spotted damage of varying intensity has appeared in those years not marked by severe outbreaks. Weevil damage has appeared rarely in that portion of Gunnison County along the north fork of the Gunnison River. Ouray County has experienced occasional damage. Garfield County has never suffered material damage, but some local injury occurred in 1932-38. No damage has been reported from Montezuma, Eagle, Pitkin, Weld, or Larimer Counties.

APPRAISAL, 1936-38

The appraisal surveys in Colorado were limited to Mesa, Delta, and Montrose Counties, which have experienced the most serious weevil damage.

1936.—In Mesa County 75 percent of fields were grayed by feeding of weevil larvae, the injury ranging from light to severe. Delta County had spotted moderate damage; one area showed 14 percent and another small area 90 percent of fields grayed. Weevil injury in Montrose County was negligible. A small percentage of the acreage in Mesa County was sprayed.

1937.—Weevil larvae grayed 5 percent of fields in Mesa County, 25 percent in Delta County, and 5 percent in Montrose County, but injury was restricted to plant tops and economic loss was slight. Considerable graying of plants by light frosts and drying winds gave the appearance of greater damage unless examined at close range. Weevil injury was negligible when the alfalfa was in the bud stage; the damage resulted from delayed first harvest and was associated with poor stands and stunted growth. The first crop was harvested in Mesa County June 5-20, in Delta County June 10-25, and in Montrose County June 15-30, when the alfalfa was in an advanced stage of growth and well in bloom, with second-crop shoots ½ to 1½ inches long, except in Delta County, where they were ¼ inch long. County agents reported 100 acres dusted in Mesa County and 10 acres in Montrose County.

1938.—Mesa, Delta, and Montrose Counties each had approximately 10 percent of fields grayed by feeding of weevil larvae, but only about 1 percent in each county showed severe damage. Injury coincided with

poor growth and occurred before the alfalfa reached the flower-bud stage late in May, by which time grown larvae predominated and cocooning was proceeding rapidly. No further injury developed, and weevil populations were at subinjurious levels in other fields. The first alfalfa crop was harvested at different stages of maturity, ranging from the flower-bud stage or slightly before during the latter part of May to full bloom at the end of June. Cutting was interrupted by threatening weather and rain storms during the first half of June. There was no spraying or dusting.

FEATURES OF AREA

Weevil damage in west-central Colorado is promoted by (1) acceleration of sexual maturity in the overwintering adults, which results in the early appearance of the larvae in the spring and the development of injury to the first crop before or by the time it is mature, and (2) lessened effectiveness of the parasite *Bathyplectes curculionis* owing to the constant abundance of the secondary parasite *Eupteromalus viridescens* (Walsh) and the consequent emergence of a comparatively large proportion of new-generation adult weevils before the first harvest. Damage is also aggravated by poor stands, stunted growth, and in some seasons by delayed harvest.

Idaho

HISTORY

The following history of alfalfa weevil damage in Idaho is based on information supplied by W. E. Shull, entomologist of the University of Idaho. During the early phase, 1920-23, the western counties of Washington, Payette, Gem, Canyon, and Ada experienced from 1 to 3 years of widespread and severe damage. The south-central counties of Gooding, Twin Falls, and Jerome, the southeastern counties of Franklin, Oneida, Power, and Bannock, the more centrally located counties of Custer, Blaine, and Butte, and the eastern counties of Bingham, Bonneville, Jefferson, Madison, Fremont, and Clark had similar damage during 1 or 2 seasons. After 1923, severe widespread damage continued sporadically and mostly in the eastern counties of Bingham, Bonneville, Jefferson, Madison, and Fremont. The records of the State entomologist showed its occurrence in Madison County during 1927, 1930, 1931, and 1933, in Fremont County during 1927, 1931, and 1933, and in Bonneville County during 1934. The weevil damage recorded since 1923 has been rare and spotted within localized areas of southern and western Idaho, having been recorded in Cassia County during 1930 and 1931 and in Washington, Canyon, and Adams Counties during 1935.

APPRAISAL, 1936-38

The appraisal surveys were conducted in selected typical areas of the State. Washington, Payette, Gem, Canyon, and Ada Counties were selected to typify the lower Snake River Valley of western Idaho; Gooding, Jerome, Twin Falls, and Cassia Counties to represent the south-central section; and Bannock, Bingham, Bonneville, Jefferson, Madison,

and Fremont Counties to represent the upper Snake River Valley of eastern Idaho.

1936.—Washington, Payette, Gem, Canyon, and Ada Counties experienced negligible loss, with only an occasional field grayed by weevil larvae. Alfalfa was in the flower-bud stage during the last week of May. A small percentage of fields was cut then, but the first crop was harvested, mostly from June 10-20, when the plants were in full bloom, with the second-crop shoots several inches long. Gooding, Jerome, Twin Falls, and Cassia Counties had no weevil damage. An overmature first crop of alfalfa was harvested mostly from June 12-25. Bannock, Bingham, Bonneville, Jefferson, Madison, and Fremont Counties had 1 percent of fields grayed on June 15-17, when the alfalfa was approaching full bloom, with second-crop shoots 1½ to 2 inches tall. At the end of May the crop was in the flower-bud stage with no second-crop shoots developed. The first crop was cut mostly from June 15-30, which was a week to 10 days earlier than usual because of the early season, but was 10 days to 2 weeks later than required to produce the best-quality hay and to avoid both weevil damage and build-up of the weevil population. The second crop was slightly retarded in a negligible percentage of fields.

1937.—In the lower Snake River Valley counties, weevil injury was confined to Ada and Canyon Counties, where 10 and 2 percent of fields, respectively, were grayed by larval feeding confined to plant tops, which resulted in slight loss. Otherwise weevil populations were at subinjurious levels throughout the area. From 60 to 90 percent of fields had been harvested by June 16, when uncut fields were well in bloom and second-crop shoots were 1 to 2 inches tall. The south-central counties suffered no weevil damage, except in Gooding County where a few fields, considerably less than 1 percent, were grayed.

In the upper Snake River Valley, Bannock, Bingham, and Bonneville Counties had negligible damage and subinjurious weevil populations, except in the Blackfoot-Firth area of Bingham County, where, on June 22-23, 50 percent of fields were grayed with moderate economic damage. This damage was associated with poor growth. The alfalfa was well in bloom, with second-crop shoots ½ inch long, and the first harvest had just begun, with 10, 5, and 1 percent of fields cut in the respective counties. On July 2-3, 80, 75, and 50 percent of fields were cut, and uncut fields were approaching full bloom, with second-crop shoots 1½ inches tall. No retardation of the second growth had occurred in fields cut before July 2-3, but slight retardation was foreshadowed in occasional, uncut, severely damaged fields after their harvest because of the abundance of weevil larvae and the production of second-crop shoots. Jefferson, Madison, and Fremont Counties had 10, 4, and 1 percent of fields grayed, respectively, on June 22, but the feeding was restricted to plant tops and economic loss was slight. For the most part, weevil populations were at subinjurious levels. Alfalfa was in the flower-bud stage, and second-crop shoots ¼ inch long were mostly below the soil surface. Growth was fair and variable. Less than 1 percent of fields had been cut. On July 3 alfalfa was nearing full bloom, with second-crop shoots ½ to 1 inch long, but only 30, 15, and 10 percent of fields had been cut in the respective counties. Completion of the first harvest was expected by July 10-15.

1938.—On June 5-6 Washington, Payette, Gem, Canyon, and Ada

Counties had slight damage, estimated at 1 percent of fields in the area grayed, but practically all injury was concentrated in the Boise River Valley of western Ada and eastern Canyon Counties and damage was severe in affected fields. Elsewhere in this area weevil populations were subinjurious. The alfalfa was well in bloom, and second-crop shoots averaged one-quarter inch long, except in Ada County, where they were less advanced. The first harvest was well under way with 50 to 85 percent of fields cut, except in Ada and Canyon Counties, where 10 to 15 percent had been cut. This cutting was earlier than usual and was undertaken in an effort to prevent maturing and seeding of grasses, particularly cheat and foxtail, which were unusually abundant in alfalfa fields. Gooding, Jerome, Twin Falls, and Cassia Counties showed slight weevil damage in the area as a whole, but since it was concentrated upon seed fields in Jerome and Gooding Counties, where the first alfalfa growth is commonly managed for seed production, it caused much concern and considerable loss. Bannock, Bingham, Bonneville, Jefferson, Madison, and Fremont Counties in the upper Snake River Valley had severe and widespread weevil damage, with 0, 50, 50, 60, 65, and 50 percent of fields grayed in the respective counties on June 30. In approximately half of the damaged fields the alfalfa was almost completely destroyed and in the other half the damage was consistently heavy. Alfalfa growth was poor in much of the area but was well in bloom, and second-crop shoots were one-quarter to one-half inch long. Notwithstanding, the first harvest was proceeding slowly with 60 to 75 percent of fields cut in Bingham and Bonneville Counties but only 40 percent in Fremont, Jefferson, and Madison Counties. Cutting at an advanced stage of maturity is the general practice in this area, but the harvest was unusually delayed this season by continued unfavorable weather during the latter half of June. Occasional cut fields showed severe damage to the young second growth, and further damage of this type was in prospect because of the abundance of weevil larvae and greatly belated cutting. In Bannock County the first harvest was 90 percent complete and the second crop was 1 to 10 inches high, indicating that earlier cutting, possibly during the favorable harvest weather of early and mid-June, would be advantageous.

FEATURES OF AREA

In the lower Snake River Valley of western Idaho, alfalfa stands and soils are generally good. Most of the weevil damage occurs in river valleys, such as the Boise River, tributary to the Snake River.

Stands and soils in south-central Idaho are also generally good. Nearly all the weevil damage is associated with fields managed for seed production, which entails belated harvest of the first growth.

In the upper Snake River Valley in eastern Idaho there are many thin stands and considerable areas of poor soils, particularly in Jefferson and Madison Counties. Many areas are managed for seed production, and on other acreage also the hay is overmature when harvested. These factors are conducive to injurious weevil populations.

Montana

Big Horn County has no history of economic damage by the alfalfa weevil. Weevil populations are small.

Nebraska

HISTORY

The history of alfalfa weevil damage in Nebraska is brief, restricted to the western counties, and entirely unimportant up to 1940. Nevertheless, great interest attaches to this record because it includes the only instances of economic damage by the alfalfa weevil east of the Rocky Mountains.

The first infestation found in the State was in 1928 near Henry in the extreme southern part of Sioux County, but the first noteworthy injury was reported in 1934 from northern Sioux County, some 50 miles from Henry. The damage was severe but was limited to a few fields being managed for seed production. In 1938 economic damage was reported near Henry in two fields in Scotts Bluff County, found infested in 1935. Available data on these Nebraska infestations are presented below. No weevil damage has occurred in Banner, Box Butte, Dawes, Kimball, Morrill, or Sheridan Counties, where weevil populations are present but extremely low.

APPRAISAL, 1936-38

Weevil damage in Nebraska was studied and appraised at the only points where injury occurred, in Sioux and Scotts Bluff Counties.

1936.—Only one field in Sioux County showed economic damage, and serious damage was confined to half of it. The first growth was mature. After the first cutting on June 15, grown larvae, approximating 50 to the square foot, promptly and completely destroyed the second-crop shoots then present, but a multitude of additional second-crop shoots started promptly and were uninjured. Noticeable larval feeding occurred in two other fields. Weevil larvae were present but extremely scarce in all parts of the county except the northeast corner. This widespread occurrence over such a large area with fields so widely scattered suggested that the alfalfa weevil had been here for a good many years.

1937.—On June 16 no fields in Sioux County were injured by weevil larvae sufficiently to turn gray. Only one field showed slight feeding, confined to the plant tips, and larval populations were at low levels. The alfalfa was well in bloom, with second shoots ½ to 1 inch long. Growth was poor. The first harvest had not begun but was expected by June 20 to July 5.

1938.—In Sioux County the weevil populations were very small and there was virtually no injury. In Scotts Bluff County two fields were grayed by weevil larvae. Shortly after the middle of June these fields were in full bloom, with second-crop shoots already 1 to 2 inches tall. Nearly all the weevil larvae were mature, and cocoons numbered several to the square foot. No other fields were injured, and in these two the cause was the greatly belated harvest of the first crop.

FEATURES OF AREA

Alfalfa stands in Sioux County are generally poor and frequently show poor growth. The parasite *Bathyplectes curculionis* is present and highly effective. All crop damage up to 1940 has resulted from belated cutting.

Nevada

HISTORY

The following historical statement of alfalfa weevil damage in Nevada, from the earliest known infestations, is summarized from data supplied by George G. Schweis, director of the Nevada Bureau of Plant Industry. Most Nevada counties in which the alfalfa weevil has been found have experienced a period of several years' duration in which weevil damage has been severe, followed by lighter, spotted damage, frequently of sporadic occurrence. Washoe, White Pine, Pershing, and Storey Counties, first found infested in 1920-22, experienced severe damage from about 1926 to 1930 and spotted damage of lesser degree since. Churchill and Lyon Counties, reported infested in 1924, suffered severe damage from 1927 to 1932, since then restricted to isolated spots. Weevil infestations were discovered in Ormsby and Mineral Counties during 1926, and heavy damage was reported from the former in 1929 and from the latter in 1930-33. Damage in the western counties had thus subsided from the most severe stage by 1933, except in Douglas County, first found infested (in 1927) several years after the others, where severe damage began in 1935 and continued through 1938. The northern counties of Humboldt, Elko, and Lander were initially found infested in 1928-30. Severe damage began in Elko and Lander Counties during 1934 and in Humboldt County 2 years later, and continued in all three counties from 3 to 5 years, these still being reported in 1940 as heavily infested. Lincoln County, in the southern part of the State, was found infested in 1928, and severe damage was reported there in 1931. Special interest attaches to the indication provided by these data that the interval from first discovery of the weevil to the first report of severe damage ranged from 3 to 8 years and averaged 4 years, and that the duration of severe damage ranged from 1 to 6 years and averaged 3 years.

One alfalfa field in Clark County, situated in the extremely hot southernmost part of the State, was found infested in 1935, but much additional sweeping in the few nearby alfalfa fields failed to reveal weevil infestation in any of them. Growers of the locality and the county agent immediately undertook measures to exterminate the infestation. Intensive sweeping conducted by representatives of the Bureau of Entomology and Plant Quarantine—22,700 sweeps in 33 fields during 1937 and 31,800 sweeps in 23 fields during 1938—resulted negatively. All surveying in 1938 was within a 3-mile radius of the field found infested in 1935, in which the alfalfa was destroyed at that time by burning and plowing.

APPRAISAL, 1937-38

Appraisal surveys were made during 1937-38 in Churchill, Washoe, and Douglas Counties and in 1938 in Lyon County.

1937.—Churchill County showed negligible economic damage, with less than 1 percent of the first crop injured. Washoe County had slight economic damage; 10 percent of fields suffered light injury to the first crop, which was approaching full bloom when cut, mostly from June 18-30. The county agent stated that 1,500 acres had been sprayed and 1,700 acres dusted. Douglas County experienced severe economic damage;

50 percent of fields showed heavy feeding involving the greater portion of the plants. Undamaged fields were approaching full bloom, with second-crop shoots 1 inch long. The first crop was harvested June 18 to July 1, 2 to 3 weeks after the flower-bud stage. The second growth on 5 percent of fields was being retarded by weevil larvae at the time of the appraisal, and the prospect was that more fields would be similarly held back when the first growth was removed, because of the abundance of larvae and the presence of second-crop shoots above ground. No control was attempted.

1938.—Churchill County had slight damage; 5 percent of fields were grayed. Lyon County showed slight damage, with 1 percent of fields grayed. Washoe County showed slight damage; 10 percent of fields were grayed and half of these were severely damaged. Douglas County suffered severe and widespread damage; 50 percent of fields were grayed and the actual losses were large. Although plants had developed beyond the flower-bud stage when surveyed June 15-16, only 10 percent of fields had been harvested and the harvest was expected to continue to July 1. Large populations of weevil larvae threatened some retardation of the second growth in fields harvested after the young shoots had appeared.

FEATURES OF AREA

Much of the alfalfa weevil damage in western Nevada is associated with thin stands and poor growth or is the result of belated cutting, sometimes unavoidable on large acreages where haying is a continuous summer operation and it is impossible to cut all fields at the flower-bud stage of growth.

Oregon

HISTORY

The following brief history of alfalfa weevil damage in Oregon is summarized partly from data supplied by Don C. Mote, entomologist of the Oregon Agricultural Experiment Station, and from data accumulated by the Bureau of Entomology and Plant Quarantine. Malheur County, found infested in 1919, was recorded by the county agent as having had severe damage during the period 1920-24, but since has had little damage. P. T. Fortner, county agent, reports that in Baker County, found infested in 1922, weevil damage averaging 30 percent reduction of the first crop yield affected an average of 600 acres in the period 1922 to 1924 and an average of 900 acres from 1934 to 1940. No damage has been reported in Union County, first found infested in 1924. Weevil infestation was reported from Jackson County in 1929 and by the end of 1935 had spread throughout the county, having caused spotted damage of varying intensity during this period. During 1932-35 the weevil affected the first alfalfa growth in 10 to 40 percent of fields and caused slight retardation of the young second growth. Josephine, Harney, and Douglas Counties, in which the alfalfa weevil was discovered in 1933, 1936, and 1938, respectively, have no history of economic damage.

APPRAISAL, 1936-38

Appraisal studies were made in Malheur and Baker Counties in eastern Oregon and Jackson County in southwestern Oregon.

1936.—In Malheur County weevil damage was entirely negligible. Baker County experienced severe weevil damage on one-fifteenth (2,500 acres) of the county's alfalfa acreage located in Eagle Valley, a lower valley where three alfalfa crops are cut annually. Here 80 percent of the fields were turned gray and nearly all the others showed moderate to heavy injury. In Baker Valley, where most of the alfalfa is grown and only two crops are harvested yearly, damage was absent and weevil larvae were scarce. No control was attempted.

1937.—Malheur County had negligible damage. Baker County showed no weevil damage except in Eagle Valley, where slight economic damage occurred; 35 percent of fields were grayed by weevil larvae, but the feeding was mostly confined to the uppermost portions of plants. No control measures were used. Jackson County (Rogue River Valley of southwestern Oregon) experienced slight damage to the first crop, 10 percent of fields being spotted with gray and only the upper part of plants being involved. There was no damage on May 22 when the first growth was at the flower-bud stage, but most fields were not harvested until June 3-15 because of rainy, cloudy weather, and 15 percent were not cut until after June 15 when the fields were half in bloom, with second-crop shoots 3 inches tall. This delay in harvest allowed first-crop injury to develop and also allowed larvae to congregate on second-crop shoots, causing moderate feeding and slight retardation of the second crop in 10 percent of fields. A small percentage of the acreage was sprayed or dusted.

1938.—In Malheur County damage was negligible. No weevil damage occurred in Baker County, except for slight economic damage in Eagle Valley, where 10 percent of fields were grayed by larval feeding and about half these fields were severely injured, primarily because of thin stands and poor growth. The first alfalfa crop was cut earlier than usual, 20 percent of fields when the alfalfa was in the flower-bud stage early in June, but this was more of an attempt to eliminate grasses, in which the 26-inch alfalfa was hidden, than to control the weevil. Jackson County had slight economic damage; 25 percent of fields were grayed, but the larval feeding was confined to the uppermost portions of the alfalfa plants. Fifty percent of fields were cut by May 26 and were little injured; damage occurred mostly in fields cut later, up to June 20. A small percentage of the acreage was treated with calcium arsenate.

FEATURES OF AREA

Much of the weevil damage in Eagle Valley, Baker County, occurs in the poorer hillside fields having shorter growth. Belated cutting, usually mostly after June 20, is also responsible for a large proportion of the weevil damage. In the Rogue River Valley of southwestern Oregon (Jackson County) alfalfa weevil damage is based upon the prevalent thin stands and weedy condition of alfalfa fields, and is frequently aggravated by delayed harvest enforced by cloudy, rainy weather at the time when alfalfa reaches the flower-bud stage. The parasite *Bathy-*

plectes curculionis has been introduced and has increased to approximately the same level of abundance as in the older infested areas of Utah and is now similarly as effective in these older areas.[6]

South Dakota

There is no history of economic damage by the alfalfa weevil in Fall River and Custer Counties. Weevil populations found there are extremely small.

Utah

HISTORY

No year-by-year record of weevil damage in Utah is available, and the following synopsis is based upon incomplete data compiled from records of the Utah Agricultural Experiment Station and the Salt Lake City laboratory of the Bureau of Entomology and Plant Quarantine, supplemented by generalized statements of T. R. Chamberlin of the Bureau. During the early years (1904-09) weevil damage occurred in all counties known to be infested, including Salt Lake, Summit, and Davis Counties, with the most severe injury affecting the early infested areas of Salt Lake County. During 1910-12 weevil infestations were discovered in 11 additional counties, and spotted severe damage was recorded in Morgan and Utah Counties as well as in the 3 counties previously named.

T. R. Chamberlin states that the most serious injury which came to his attention during the period 1913-16 was in Salt Lake and Summit Counties, but that by 1918 there was a noticeable reduction of injury in Salt Lake County and little damage occurred there to the end of his observations in 1926. He also recalls that serious damage occurred in Box Elder County during 1918, and about this time damage increased considerably in the central section of the State. His observations during 1923-26 showed very little injury in central and northern Utah.

Available information indicates that years of weevil damage, varying in both intensity and extent, were interspersed with periods of comparative freedom from injury in many sections of the State and suggests the following classification: Frequent damage, Box Elder, Salt Lake, Utah, Millard, Sanpete, and Sevier Counties; occasional damage, Weber, Wasatch, Tooele, Juab, Duchesne, and Uintah Counties; rare damage, Summit, Davis, Cache, Morgan, Rich, Carbon, Emery, Beaver, Piute, Iron, Garfield, Grand, San Juan, Wayne, Kane, Washington, and Daggett Counties.

APPRAISAL, 1936-38

The status of the alfalfa weevil in Utah during recent years is shown by appraisal studies conducted in several counties located in the northern and central sections of the State.

1936.—In Salt Lake County moderate economic damage affected 25 percent of fields. The first alfalfa growth was in the flower-bud stage during the last 10 days of May. No economic damage had developed at

[6] See footnote 4 (p. 9).

that time, but only 50 percent of fields were harvested then. Rain and unsettled weather began May 31, nearly half of the hay crop was not harvested until June 7-18, and about 5 percent was cut after June 18. Of that half of fields cut on and after June 7, approximately 15 percent were gray and 25 percent more showed moderate to heavy feeding without change of color. Destruction averaged one-third of the leaf surface on the upper 3 to 4 inches of the plants. No artificial control measures were used. Box Elder County had negligible economic damage. Sixty percent of fields were uncut on June 9 and four-fifths of these were virtually untouched by the weevil. Very few fields in the county showed severe damage, and this was limited to the upper leaves. Davis, Weber, Cache and Morgan Counties had negligible damage, and weevil populations were subinjurious. In Millard County economic damage occurred in 5 to 10 percent of fields. The alfalfa was at the flower-bud stage late in May, and a small percentage of fields were cut then, but unsettled weather and heavy rains delayed the first harvest. Approximately 450 acres were sprayed. Duchesne and Uintah Counties showed no damage whatever, and weevil larvae were extremely scarce. In Sanpete and Sevier Counties 5 percent of fields were grayed by weevil damage. Wasatch County had no damage.

1937.—In Salt Lake County slight economic damage appeared in 5 percent of fields; there was no spraying or dusting. In Box Elder County there was slight economic damage in 5 percent of fields. In Cache County there was no damage and weevils were scarce. Millard County had severe economic damage in 50 percent of fields; throughout the county weevil larvae were abundant and their feeding, mostly of a coarse, ragged nature, involved the greater portion of the plants. The county agent reported that 500 acres were sprayed and 200 dusted. Utah County had no damage, and the greater part of the first crop was cut at about the flower-bud stage of growth. Sanpete County had slight economic damage in 5 percent of fields; all this injury was concentrated in the Gunnison area, where 15 percent of fields were grayed from larval feeding on the upper part of the plants. Poor growth was evident, particularly in the Gunnison area, and these fields were most affected by weevil damage. Sevier County showed negligible economic damage; considerably less than 1 percent of the fields were damaged sufficiently to turn gray. On June 8 no fields in Uintah County were damaged sufficiently to turn gray, and feeding was observed in only a few fields, where it was confined to plant tips, resulting in entirely neglible loss of hay. The alfalfa was reaching the flower-bud stage with scattered blossoms, and hardly any second-crop shoots showed above ground. Cutting had not begun and was expected June 15 to July 1.

1938.—In Salt Lake County slight economic damage occurred in 5 percent of fields. By beginning the first harvest with the appearance of injury, farmers averted more severe damage. There was no spraying or dusting. Box Elder County experienced moderate economic damage in 15 percent of fields. Prompt harvesting upon the appearance of injury averted more severe damage, since the general level of weevil abundance was rather high and menaced approximately 35 percent more fields. Most of the alfalfa was cut at about the flower-bud stage. Cache County had slight economic damage in 1 to 5 percent of fields. Millard County

experienced severe economic damage in 30 percent of fields on June 10, when the alfalfa was in the flower-bud stage with scattered blossoms, and second-crop shoots were one-quarter inch long, but only 5 percent of the fields were cut, and the indications were that possibly 50 percent would be grayed by the weevil. The abundance of weevil larvae, the height of young shoots, and delay in harvest indicated the prospect of at least some retardation of the second growth. Utah County had negligible economic damage, with less than 1 percent of fields grayed. Ninety percent of the first crop was cut in the flower-bud stage by June 10. Sanpete County showed severe economic damage in 35 percent of fields on June 14, when the alfalfa was at the flower-bud stage with scattered blossoms, and second-crop shoots had not appeared above ground. This damage was principally associated with poor growth. Only 10 percent of the fields were cut, and the abundance of weevil larvae indicated that late-cut fields in which the second growth had already started might suffer slight retardation of the second crop. Sevier County had slight economic damage in 10 percent of the fields. In Wasatch County on June 20 economic damage was negligible; the alfalfa was in the flower-bud stage and 40 percent of the fields had already been harvested. Duchesne County showed slight economic damage in 5 percent of the fields; the alfalfa was well in bloom on June 20-21, with only 75 percent of the fields cut. Uintah County had moderate economic damage in 15 percent of fields and an additional 10 percent were on the verge of turning gray; the alfalfa was well in bloom, with only 40 percent harvested. No injury to the young second crop had occurred in fields already cut, but the possibility of slight retardation was indicated for heavily infested fields in which the first harvest was delayed until the second growth shoots were well above ground.

FEATURES OF AREA

Much of the weevil damage in northern Utah counties is associated with thin stands and poor growth, and, although the general practice is to cut alfalfa at or soon after the bud stage, injury is commonly aggravated in some of the fields by delayed harvest and in a larger number of them when unfavorable haying seasons occur.

In central Utah counties the general practice is to cut more mature hay, and this tendency, in conjunction with the extremely varied management of fields for seed production which is common in this area, is conducive to weevil injury. Here also weevil damage is worse in fields of thin stands and poor growth, which are rather prevalent in this section of the State.

Wyoming

HISTORY

Summarizing the alfalfa weevil situation in Wyoming, State Entomologist C. L. Corkins stated: "There has never been more than 'moderate' damage at any time. I have listed the places and years when damage was distinctly noticeable, which has occurred in only 3 counties." His list is as follows: Uinta County, moderate (in 1938); Fremont County, moderate (in 1938); Natrona County, moderate (in 1932).

APPRAISAL, 1938

Weevil damage in Wyoming was appraised only in Fremont County, during 1938.

1938.—Fremont County had 10 percent of fields grayed by larval feeding, but injury was slight except in a few fields. Damage was associated with fields being managed for seed production. The first growth of alfalfa was being harvested at an advanced stage of development.

SUMMARY

The spread of the alfalfa weevil (*Hypera postica* (Gyll.)) in the United States during the period 1904-40 is shown by the record of original discoveries of the insect in 141 counties located in 11 western States.

The historical summaries show that the alfalfa weevil has caused little or no damage in certain parts of the area it has infested in the United States, and spotted heavy damage intermittently in other parts. In general, weevil damage has subsided greatly from that caused soon after its first appearance in most areas, and this subsidence has been concurrent with the introduction, domestic redistribution, and natural spread of the alfalfa weevil parasite *Bathyplectes curculionis* and the adoption of improved cropping practices.

The many case histories of alfalfa areas in recent years show that spotted damage of varying intensity caused by the alfalfa weevil occurs intermittently and that much of it could be avoided by harvesting the first crop at the flower-bud stage of growth. However, in limited areas, thin stands and poor growth, biological factors, large acreages, or management of fields for seed production regularly operate against early cutting as a successful control, and weather conditions intermittently prevent employing this control. In such cases control may be obtained by insecticidal treatment.

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